Citation:

Fowler SP, Williams K, Resendez RG, Hunt KJ, Hazuda HP, Stern MP. Fueling the obesity epidemic? Artificially sweetened beverage use and long-term weight gain. *Obesity* (Silver Spring). 2008 Aug; 16 (8): 1,894-1,900. Epub 2008 Jun 5.

PubMed ID: 18535548

Study Design:

Prospective Cohort Study

Class:

B - Click here for explanation of classification scheme.

Research Design and Implementation Rating:

NEUTRAL: See Research Design and Implementation Criteria Checklist below.

Research Purpose:

To examine the relationship between artificially sweetened beverage (ASB) consumption and long-term weight gain in the San Antonio Heart Study.

Inclusion Criteria:

Aged 25-64 years old; residing in San Antonio, TX.

Exclusion Criteria:

Participants with incomplete data on baseline ASB dose, baseline and follow-up body mass index (BMI) and all covariate data.

Description of Study Protocol:

Recruitment

San Antonio Heart Study consisted of adults residing in households randomly chosen from San Antonio neighborhoods (specific sample strategy described in previous publication).

Design

- Prospective cohort study
- Participants recruited in two cohorts:
  - Cohort 1 from 1979 to 1982
  - Cohort 2 from 1984 to 1988.

Dietary Intake/Dietary Assessment Methodology

- Cohort 1 asked, "How many bottles or cans of soft drinks do you drink per week?" (similar assessment for cups of coffee and cups or glasses of tea)
- Cohort 2 asked how often they drank these beverages and how many beverages they drank per occasion
- At baseline, weekly consumption of soft drinks, coffee, and tea were estimated. Participants reporting soft drink use were asked whether they usually drank sugar-free sodas, regular sodas or similar amounts of each; their AS soda dose was calculated accordingly. For abstainers, AS soda dose was set equal to zero. “Usual” sweeteners for coffee and tea were ascertained, and AS dosage calculated accordingly (or set equal to zero for abstainers). Participants were also asked whether they “usually” used sugar or sugar substitutes.

Blinding Used

Not applicable.

Intervention

Not applicable.

Statistical Analysis

- Logistic regression was used to adjust odds ratios (ORs) for baseline BMI, as well as gender and ethnicity; baseline age, education, socioeconomic index, exercise frequency, and smoking status; interim change in exercise level; and interim smoking cessation (“demographic/behavioral covariates”), with ordinal categories of AS doses per day as a predictor variable.
- Analysis of covariance was used to assess associations between ASB consumption category and ΔBMI. In logistic regression and analysis of covariance models, linear trend was assessed by models using the ordinal category of ASB doses per day as a continuous measure
- Analyses of ΔBM, with adjustment for baseline BMI and demographic/behavioral covariates, were performed for the entire sample. Within cohort 2, they were repeated separately by baseline AS use status (present or absent), with additional adjustment for follow-up AS status. Within cohort 2, these analyses were also repeated among participants whose AS use status (present or absent) remained unchanged at follow-up.

Data Collection Summary:

Timing of Measurements

Height, weight, and ASB consumption was measured at baseline and seven to eight years later.

Dependent Variables

- Incidence of overweight/obesity (BMI$\geq$2 5kg/m^2)
- Incidence of obesity (BMI$\geq$30kg/m^2)
- BMI change (Δ) by follow-up.

Independent Variables

Artificially sweetened beverages (ASB), including sodas, coffee, and tea, consumed per week at baseline.

Control Variables

- Baseline BMI
- Gender
- Ethnicity
- Baseline age
- Education
- Socioeconomic index
- Exercise frequency
- Smoking status
- Interim change in exercise level
- Interim smoking cessation.

Description of Actual Data Sample:

- *Initial N:* 5,158 adults
- *Attrition (final N):* Of 4,998 surviving participants at seven to eight years, 3,682 adults (74%) had follow-up data
- *Age:*
  - No AS use=43.5 (11.0) years
  - AS use=44.7 (10.7) years
- *Ethnicity:*
  - Mexican Americans and non-Hispanic whites
  - No AS use=70.5% Mexican Americans
  - AS use=56.6% Mexican Americans
- *Other relevant demographics:* None
- *Anthropometrics:* Baseline BMI:
  - No AS use=26.9 (5.3) kg/m^2
  - AS use=27.9 (5.6) kg/m^2
- *Location:* United States.

Summary of Results:

Key Findings

- A significant positive dose-response relationship emerged between baseline ASB consumption and all outcome measures (incidence of overweight/obesity, incidence of obesity, and BMI change), adjusted for baseline BMI and demographic/behavioral characteristics
- Consuming>21 ASBs per week (vs. none) was associated with almost-doubled risk of OW/OB (OR=1.93; P=0.007) among 1,250 baseline normal-weight (NW) individuals, and doubled risk of obesity (OR=2.03; P=0.0005) among 2,571 individuals with baseline BMIs <30kg/m^2.
- Compared with nonusers (+1.01kg/m^2), ΔBMIs were significantly higher for ASB quartiles two to four: +1.46 (P=0.003), +1.50 (P=0.002), and +1.78kg/m^2 (P<0.0001), respectively. Overall, adjusted ΔBMIs were 47% greater among AS users than non-users (+1.48kg/m^2 vs. +1.01kg/m^2, respectively, P<0.0001).

Author Conclusion:

- The authors concluded that they observed a positive dose-response relationship between ASB consumption and long-term weight gain. Further, they noted that the association does not establish causality, but additional research is needed to evaluate the possible impact of AS use on the risk ofobesity
- They raise the question whether AS use might be fueling, rather than fighting the escalating obesity epidemic.

Reviewer Comments:

- *ASB use was self-reported using a few questions, rather than estimated using dietary records or recalls*
- *Possible under-reporting of energy intake by overweight and obese individuals not discussed.*

Research Design and Implementation Criteria Checklist: Primary Research

Relevance Questions		
1.	Would implementing the studied intervention or procedure (if found successful) result in improved outcomes for the patients/clients/population group? (Not Applicable for some epidemiological studies)	Yes
2.	Did the authors study an outcome (dependent variable) or topic that the patients/clients/population group would care about?	Yes
3.	Is the focus of the intervention or procedure (independent variable) or topic of study a common issue of concern to nutrition or dietetics practice?	Yes
4.	Is the intervention or procedure feasible? (NA for some epidemiological studies)	Yes
Validity Questions		
1.	**Was the research question clearly stated?**	Yes
1.1.	Was (were) the specific intervention(s) or procedure(s) [independent variable(s)] identified?	Yes
1.2.	Was (were) the outcome(s) [dependent variable(s)] clearly indicated?	Yes
1.3.	Were the target population and setting specified?	Yes
2.	**Was the selection of study subjects/patients free from bias?**	Yes
2.1.	Were inclusion/exclusion criteria specified (e.g., risk, point in disease progression, diagnostic or prognosis criteria), and with sufficient detail and without omitting criteria critical to the study?	Yes
2.2.	Were criteria applied equally to all study groups?	Yes

2.3.	Were health, demographics, and other characteristics of subjects described?	Yes
2.4.	Were the subjects/patients a representative sample of the relevant population?	Yes
3.	**Were study groups comparable?**	Yes
3.1.	Was the method of assigning subjects/patients to groups described and unbiased? (Method of randomization identified if RCT)	Yes
3.2.	Were distribution of disease status, prognostic factors, and other factors (e.g., demographics) similar across study groups at baseline?	N/A
3.3.	Were concurrent controls used? (Concurrent preferred over historical controls.)	Yes
3.4.	If cohort study or cross-sectional study, were groups comparable on important confounding factors and/or were preexisting differences accounted for by using appropriate adjustments in statistical analysis?	Yes
3.5.	If case control or cross-sectional study, were potential confounding factors comparable for cases and controls? (If case series or trial with subjects serving as own control, this criterion is not applicable. Criterion may not be applicable in some cross-sectional studies.)	N/A
3.6.	If diagnostic test, was there an independent blind comparison with an appropriate reference standard (e.g., "gold standard")?	N/A
4.	**Was method of handling withdrawals described?**	Yes
4.1.	Were follow-up methods described and the same for all groups?	No
4.2.	Was the number, characteristics of withdrawals (i.e., dropouts, lost to follow up, attrition rate) and/or response rate (cross-sectional studies) described for each group? (Follow up goal for a strong study is 80%.)	N/A
4.3.	Were all enrolled subjects/patients (in the original sample) accounted for?	Yes
4.4.	Were reasons for withdrawals similar across groups?	N/A
4.5.	If diagnostic test, was decision to perform reference test not dependent on results of test under study?	N/A
5.	**Was blinding used to prevent introduction of bias?**	Yes
5.1.	In intervention study, were subjects, clinicians/practitioners, and investigators blinded to treatment group, as appropriate?	N/A
5.2.	Were data collectors blinded for outcomes assessment? (If outcome is measured using an objective test, such as a lab value, this criterion is assumed to be met.)	Yes

5.3.	In cohort study or cross-sectional study, were measurements of outcomes and risk factors blinded?	Yes
5.4.	In case control study, was case definition explicit and case ascertainment not influenced by exposure status?	N/A
5.5.	In diagnostic study, were test results blinded to patient history and other test results?	N/A
6.	**Were intervention/therapeutic regimens/exposure factor or procedure and any comparison(s) described in detail? Were interveningfactors described?**	Yes
6.1.	In RCT or other intervention trial, were protocols described for all regimens studied?	N/A
6.2.	In observational study, were interventions, study settings, and clinicians/provider described?	Yes
6.3.	Was the intensity and duration of the intervention or exposure factor sufficient to produce a meaningful effect?	Yes
6.4.	Was the amount of exposure and, if relevant, subject/patient compliance measured?	Yes
6.5.	Were co-interventions (e.g., ancillary treatments, other therapies) described?	Yes
6.6.	Were extra or unplanned treatments described?	N/A
6.7.	Was the information for 6.4, 6.5, and 6.6 assessed the same way for all groups?	Yes
6.8.	In diagnostic study, were details of test administration and replication sufficient?	N/A
7.	**Were outcomes clearly defined and the measurements valid and reliable?**	No
7.1.	Were primary and secondary endpoints described and relevant to the question?	Yes
7.2.	Were nutrition measures appropriate to question and outcomes of concern?	Yes
7.3.	Was the period of follow-up long enough for important outcome(s) to occur?	Yes
7.4.	Were the observations and measurements based on standard, valid, and reliable data collection instruments/tests/procedures?	No
7.5.	Was the measurement of effect at an appropriate level of precision?	Yes
7.6.	Were other factors accounted for (measured) that could affect outcomes?	No
7.7.	Were the measurements conducted consistently across groups?	Yes
8.	**Was the statistical analysis appropriate for the study design and type of outcome indicators?**	Yes

8.1.	Were statistical analyses adequately described and the results reported appropriately?	Yes
8.2.	Were correct statistical tests used and assumptions of test not violated?	Yes
8.3.	Were statistics reported with levels of significance and/or confidence intervals?	Yes
8.4.	Was "intent to treat" analysis of outcomes done (and as appropriate, was there an analysis of outcomes for those maximally exposed or a dose-response analysis)?	N/A
8.5.	Were adequate adjustments made for effects of confounding factors that might have affected the outcomes (e.g., multivariate analyses)?	Yes
8.6.	Was clinical significance as well as statistical significance reported?	Yes
8.7.	If negative findings, was a power calculation reported to address type 2 error?	N/A
9.	**Are conclusions supported by results with biases and limitations taken into consideration?**	Yes
9.1.	Is there a discussion of findings?	Yes
9.2.	Are biases and study limitations identified and discussed?	Yes
10.	**Is bias due to study's funding or sponsorship unlikely?**	Yes
10.1.	Were sources of funding and investigators' affiliations described?	Yes
10.2.	Was the study free from apparent conflict of interest?	Yes